

SOUTHEASTERN ECOLOGICAL FRAMEWORK: A PLANNING TOOL FOR MANAGING ECOSYSTEM INTEGRITY

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Abstract. The southeastern United States has large areas of unique ecological character. Agricultural, silvicultural, and road development practices are having landscape fragmentation impacts on these unique ecosystems. More devastating practices associated with economic progress are quickly eclipsing these threats to the ecological processes in the region. Urban sprawl is becoming the major problem in the protection of environmental processes that protect human health. Currently natural ecosystems show trends for high losses of several ecosystem types, such as long leaf pine forests and wetlands. These ecosystems support processes that provide habitat for many endangered species while also protecting water quality for a rapidly growing population. The unmanaged growth in the southeast is placing significant stress on the remaining intact natural ecosystem. The resulting impact on the environment is a fragmentation of ecosystem processes. The impacts on the population are increased costs required to meet water quality standards and a diminished quality of life.

In order to safeguard the functionality of large ecosystem processes providing environmental services and protecting human health, threats to ecological function and conflicts in resource protection need to be identified and prioritized. Effective protection measures must be established to minimize environmental degradation from ecosystem fragmentation. The delineation of an ecological framework in the southeast can provide an opportunity to take a proactive approach to protecting ecological processes that support water quality. Utilizing a regional framework as an organizing principle for ecosystem protection provides federal agencies, state and local governments, community groups and nonprofit organizations with the ability to leverage scarce resources to meet broad environmental goals through specific on-the-ground objectives.

INTRODUCTION

One of the greatest threats to ecosystem functionality is the fragmentation of landscapes (Harris, 1984). Roads, large-scale agriculture, and suburban growth or 'sprawl', all represent changes in natural landscapes that cause natural systems to become divided into smaller and more isolated parts (Forman, 1995). Increasingly fragmented landscapes lose their ecological integrity, which can include the loss of biological diversity and the degradation of water quality and other important ecological services (Harris & Silva-Lopez, 1992; Harris et al., 1996). Prevention of these landscape changes solely at the local scale is almost impossible. By identifying a large scale, systematic regional framework, it is possible to provide a backdrop in which protection of the large-scale ecological properties and processes can be optimized for multiple benefits at a local scale (Noss, 1991).

Natural ecosystem processes provide sustainable human needs, habitat for many species and desirable recreation activities (Salwasser et al., 1996). Furthermore, these processes provide ecological services as long as they are not overloaded. The ecosystem acts as a natural filter and waste processing system as well as a buffer to areas downstream. The natural areas remaining in the southeast are under increasing pressure to provide ecological services for water quality, water quantity, storm water management, flood control, particulate matter removal and carbon sequestration, as well as food and shelter for native species (Noss, 1996). Conversion of natural land cover to accommodate urban sprawl usually causes major problems with maintaining ecosystem integrity, thus causing conflicts in land use activities and undesirable impacts from pollution where the intensity of use is greater than the assimilative capacity of the environment (Mattikalli & Richards,

1996). The fragmentation of natural ecosystems has potentially adverse impacts on the ability of a landscape to sustain ecological functions and the ability to provide environmental services (Harris, 1989; Forman & Godron, 1986).

In addition to natural areas, lands in agricultural or silvicultural use can contribute to maintaining the regional landscape's overall ecological function and quality. These lands have potential for maintaining connectivity between areas of higher ecological significance while providing direct economic benefits from production of food and fiber. So, lands in agriculture and silviculture can function as part of an ecological framework or as buffer areas around native habitat (Daniels & Bowers, 1997). Unfortunately, agricultural lands as well as natural lands are being lost to urbanization in high growth areas of the southeast.

In order to safeguard the natural environment and protect human health, threats to ecological function and conflicts in resource allocation need to be identified and prioritized. Effective and efficient protection measures must then be established to minimize environmental degradation and loss of economic well-being. This can be done by the application of a geographical information system (GIS) model to identify areas of ecological significance. The Southeastern Ecological Framework is an excellent tool to help determine where the best natural areas remain and how they can be connected into community greenspace plans that preserve the functional integrity of significant ecosystems in the southeast. When integrated with a watershed approach to resource protection and databases available for the southeast, the Southeastern Ecological Framework can identify locations of natural areas and agricultural lands endangered from urban sprawl, toxic release sites, superfund sites, water treatment facilities and non-point sources. The effectiveness of the Environmental Protection Agency's (EPA) efforts are helped by understanding the nature of the spatial relationship between natural resources and human impacts. The Southeastern Ecological Framework can also provide community groups, counties and states with a tool to think outside political or jurisdictional boundaries in planning resource protection efforts.

BACKGROUND

Many organizations such as the World Wildlife Fund, The Nature Conservancy, and the Trust for Public Land are attempting to use geographical

information system tools for identifying hot spots, priority areas, or the last great remaining places. A significant problem with any approach is identifying the appropriate scale to evaluate natural resources, the amount and consistency of data available and stakeholder involvement or local ownership of the final product (Peine, 1999). Each aspect has significant hurdles to overcome and often leaves room for improvement on any product eventually developed.

In 1995, the Southern Appalachian Man and Biosphere (SAMAB) Cooperative completed the Southern Appalachian Assessment (SAA) through the collaborative efforts of federal agencies, state agencies, universities, special interest groups, and private citizens. The effort was an attempt to evaluate the living systems of the Southern Appalachian Region – the animals, the plants, and the land, air, and water that support them – and the enormous changes that have taken place during the 20th century (SAMAB, 1996). This marked the first attempt at developing a consistent data set for evaluating natural resources in the Southern Appalachians. The SAA, however, fell short in providing useful information for local decision makers. One problem was due in large part to the complexity of the GIS tools available at the time and little training by municipal officials in the technology. A second significant problem with the SAA was that the majority of data was developed to identify trends at a county level. Providing little opportunity for understanding landscape changes within a county. Although point data and land use coverages were included in the final SAA, further difficulty lied in the fact that no analysis of the relationship of one data set with another was developed to give a firm indication of what land may be at risk from existing or potential growth in the future (Berish et al., 1999)

Land use decisions have been granted to local county governments. This trend is changing with the development of regional authorities and a greater understanding of watershed management and transportation issues, but for the most part the county government maintains control over land use planning, zoning and management. EPA has come to understand that even with the vast array of environmental regulations currently on the books, many of the goals and objectives sought by these regulatory authorities cannot be met without taking into consideration the impacts from land use decisions and related non-point sources. Specifically EPA is increasingly interested in the impact of land use decisions associated with urban sprawl and the resulting water, air and soil pollution

that hamper EPA's ability to meet Congressional mandates for human health and the environment.

The need for accountability in meeting environmental objectives and goals will be a key focal area for the Bush Administration as well as a continued strategy of Congress under the Government Performance and Results Act (GPRA). GPRA requires all federal agencies to identify goals and objectives to meet individual Agency missions. EPA has quantifiable measures designed to improve the environment, but we must also strive to protect those areas that are providing valuable economic services that are often overlooked, difficult to quantify and typically not considered in land use planning efforts. The Southeastern Ecological Framework represents an innovative and proactive strategy, rather than a reactive strategy to environmental protection. This innovative approach to natural resource protection can help to protect areas of significant ecological value now as well as the associated ecological services provided for water quality protection in the future.

METHODS

With funding from the Intermodal Surface Transportation Efficiency Act, the University of Florida developed a GIS model to identify potential greenways and trails in Florida. The analysis of ecological connectivity identifies areas of conservation significance and landscape linkages (Hector et al., 2000). The project developed the modeling protocol and the expertise for designing landscape linkages and prioritizing ecological hubs at a state-wide scale. The Florida Greenways and Trails model underwent significant public participation, comment and peer review before being finalized and used to help direct 300 million dollars per year for greenspace protection. EPA, Region 4 then awarded a cooperative agreement grant to the University of Florida Department of Landscape Architecture to develop an ecological connectivity model for the eight states in the southeast region. The purpose of the regional project is to identify lands that would aid in the protection of water resources, wetlands, and other natural areas.

The Southeastern Ecological Framework incorporates the first uniform National Land Cover Data (NLCD) set to be developed at a 30 meter resolution (Vogelmann et al., 1998). Additional data, such as significant ecological areas, important habitats for focal species, federal and state managed lands, priority ecological communities, wetlands, roadless areas, floodplains, and important aquatic systems at a state

Hub & Corridor Modeling Steps

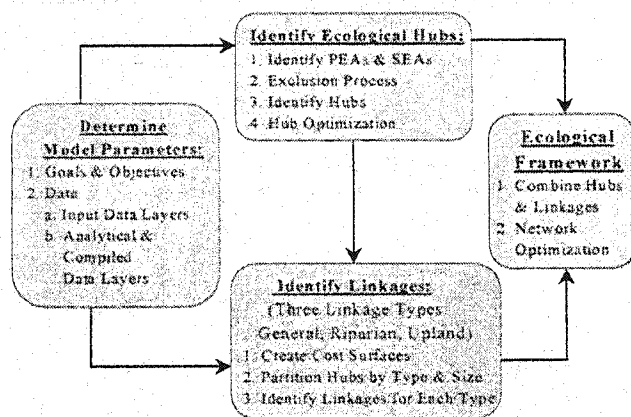


Figure 1. The southeastern ecological framework process.

wide scale was used to identify areas of potential conservation. Upland and riparian landscape linkages were then incorporated at a regional scale.

The first step in developing the Southeastern Ecological Framework was to place any existing managed area or significant location identified through statewide data sets to create a single coverage of priority ecological areas (PEAs). Second, a filter of 5000 acres was used to identify areas that could be designated as ecological hubs. Those areas of noted ecological significance not meeting the filtering criteria were placed in a secondary ecological areas (SEAs) coverage for use in developing connectivity between PEAs and high growth areas. The third step in developing the framework involved the development of a least cost path model that evaluated each adjacent cell for ecological type. To cut down on the computer processing time, the NLCD was resampled at 90 meters. Each land use was given a value between 1 and 100,000 denoting the number of cells that would be circumvented in an attempt to complete an upland or riparian connection between two PEAs. For instance, if the adjoining cell were identified as an ecologically significant area (given a value of 1) the inclusion of the cell as part of a corridor would proceed to the next cell. However, if the land use of the cell were identified as moderate intensity development (given a value of 100,000) then the model would evaluate a number of cells that corresponded to the value given to the land use to maintain ecological connectivity. Urban lands were not given a value, effectively eliminating the ability to cross over the cell, due to the inability to construct a

corridor across landscapes such as airports or urban centers. The final step was to optimize the resulting hub and corridor network to smooth the edges of the 90 meter cell resolution by returning to the 30 meter cell size for the final land cover product.

CONCLUSIONS

The finished product is a place-based GIS coverage of ecological hubs and corridors, comprised of large land tracts and a network of connectivity in the Southeast. The resulting framework represents some of the best remaining ecological areas in the southeastern states of Georgia, Florida, Mississippi, Alabama, Tennessee, Kentucky, South Carolina and North Carolina. The Southeastern Ecological Framework further indicates that there are still significant opportunities to protect a region wide framework that will be important for conserving the region's natural resources and their processes despite a burgeoning human population.

In total, 40 percent of the land area in the southeast is identified within the framework. This constitutes an enormous amount of land, however 25% of the framework total is already under some form of management, conservation or protection. Leaving 75% of the Southeastern Ecological Framework with little or no lasting protection currently in place.

The Southeastern Ecological Framework is a living draft product designed to capture the best of the existing functional processes at work in the southeast for the protection of water quality. Additional benefits

to protecting ecosystem types at a regional scale include species habitat, air quality, recreational activities and the overall quality of life for those living in the southeast. Preserving connectivity between natural areas and allowing ecosystem processes to operate at a larger scale also provides the ability of ecosystems to adapt to significant environmental changes, such as climatic variability.

The final ecological framework provides a basic regional landscape and natural resource planning tool. Its value as an organizing theme to focus and coordinate environmental protection of large scale ecological systems can be significant for the many state, federal and non-profit agencies that are involved in natural resource protection. Some examples of these are watershed protection, biodiversity and wildlife conservation, wetlands mitigation, land use planning, road right-of-way planning, wellhead protection and many similar activities. Its value as an organizing theme for local protection efforts is equally important.

An additional component of the framework is the secondary or filtered data. This provides a critical tool for formulating local community connectivity strategies. Inclusion of community place-based priorities provides a fundamental component to connecting Devon's fishing hole, neighborhoods, bike trails, schools, and local businesses into a complete picture of the landscape fabric that enhances connectivity and improves everyone's quality of life.

DISCUSSION

The framework is not a map of areas that must be protected, nor does it suggest that these are the only places that need to be protected. The Southeastern Ecological Framework provides a tool for federal, state and local governments, nonprofit organizations, and business groups to integrate local activities with watershed realities. This product can offer a wealth of opportunity as a template for Federal and state agencies and non-profits to coordinate programmatic activities that support environmental protection while maintaining ecosystem connectivity.

A green infrastructure in the southeast can have significant ecological, economic and social benefits for the region. From an environmental point of view, the Southeastern Ecological Framework can be an important component of regional, state and local conservation efforts. From EPA's perspective, the model and data can play an innovative and multi-purpose role in protecting water quality. The approach

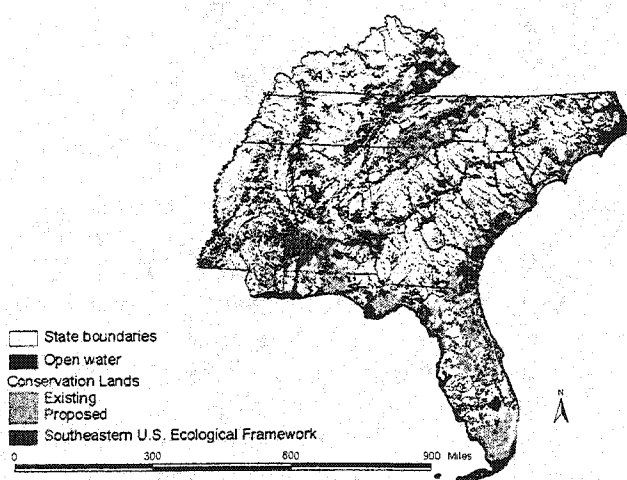


Figure 2. Optimized hub and corridor network identifying the southeastern ecological framework and existing conservation lands and lands proposed for protection.

can serve other agency missions by contributing to wildlife habitat conservation, prioritizing wetland mitigation bank locations, sequestering carbon and protecting riparian buffers.

Multiple agendas can be served through the use of the Southeastern Ecological Framework as an organizing principle. An example of leveraging agency goals in support of state, local and nonprofit objectives is the application of greenspace protection and land use development in Murray County, Georgia. The state, through the Governor's Community Greenspace Program, gains identification of ecologically significant areas that promote water quality protection. Murray County is currently developing a land use plan for their long-range development strategy. The Conasauga River Alliance, a nonprofit organization focused on watershed protection, provides significant input from environmental, business and community organizations for natural resource protection. Federal agencies obtain co-benefits from coordinating programmatic activities that support on-the-ground results. Conservation protection could be in the form of Natural Resource Conservation Service programs for riparian easement protection, wildlife refuge protection funding from Fish and Wildlife Service, Forest Service land purchases within Proclamation Boundaries, Federal Emergency Management Agency flood plain protection programs, or recreational trail development funds from the National Park Service.

The rich diversity of the Southeast's culture, species and resources are a significant aspect of the quality of life that many in the southeast have come to cherish. Stress on ecological processes from urban sprawl requires innovative solutions to protect our quality of life. The Southeastern Ecological Framework provides a fundamental approach to coordinating and leveraging scarce resources that can protect water quality and other ecological services for current and future generations.

RECOMMENDATIONS

The urban and rural interface is quickly becoming a blur as development leapfrogs planning and policies designed to provide some relief from human impacts. The Southeastern Ecological Framework provides an opportunity to act rather than react, to coordinate rather than piecemeal fragmented solutions, and to leverage resources in a time when few resources are available.

Opportunities to maintain large scale ecosystem connectivity for water quality protection, species migration and habitat diversity are diminishing. The benefits provided from ecosystem integrity must be more clearly understood and quantified in relation to other potential economic gains from land use decisions. This can provide a holistic understanding of land use options that communities are faced with on a daily basis and how those land use decisions impact the environment at a regional scale. Federal agencies must identify programmatic resources that support local decisions through the statutory missions given to them by Congress and the people while protecting ecosystem functionality.

Four critical things need to happen in order for the Southeastern Ecological Framework to be used as a tool for community resource protection. First, federal agencies need to use the framework as a prioritization tool to develop co-benefit resource protection strategies with limited resources. Second, federal agencies need to gain a better understanding of the resources they currently control and the applicability of those resources to meeting the goals and objectives of their mission. Third, federal agencies need to develop internal 'Champions' to educate local communities on how resources can be used in support of Agency goals and objectives in the context of local initiatives. Finally, economic evaluation tools to quantify ecological services must be developed to support evaluation of GPRA goals and local land use decisions.

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